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Power Factor Compensation on LV networks

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Based on ABB Power Quality Seminar

Origins of PF compensation

High electricity bill

due to penalties applied by utilities on bad power factor

- depends from country to country

- customer not always aware

Origins of PF compensation

The transformer is warm

reduced lifetime, increased technical room t°

The transformer is fully loaded

no possibility to add new loads (e.g. offshore platform)

The voltage output of the transformer is low (voltage drop)

Origins of PF compensation

Cables are warm

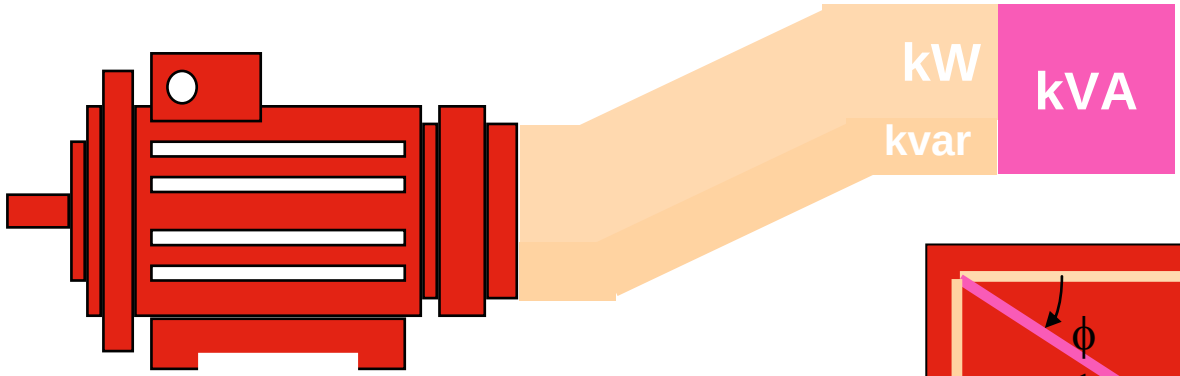
reduced lifetime

The voltage ouput at the cable extremity is low

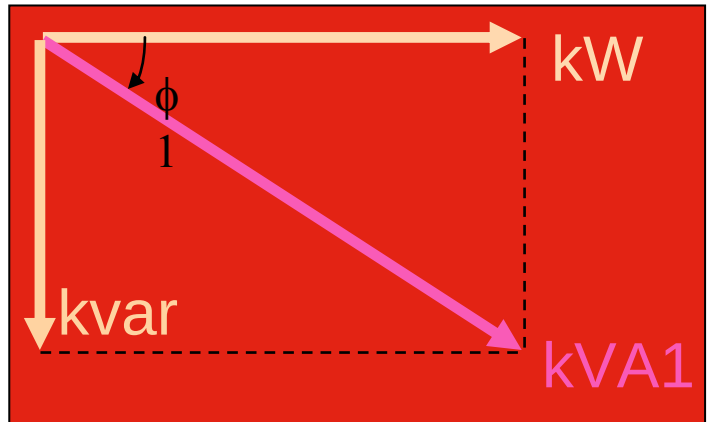
BASIC CONCEPTS

- Active power (kW)
  - ☞ performs the work (useful power)

- Reactive power (kvar)
  - ☞ sustains electromagnetic field (non useful power)



- Apparent power (kVA)
  - ☞ total power <u>consumed</u>

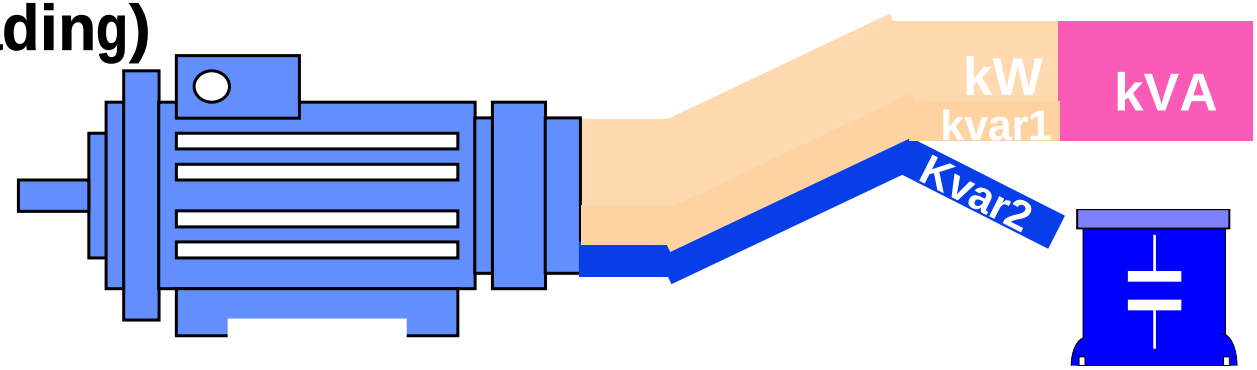


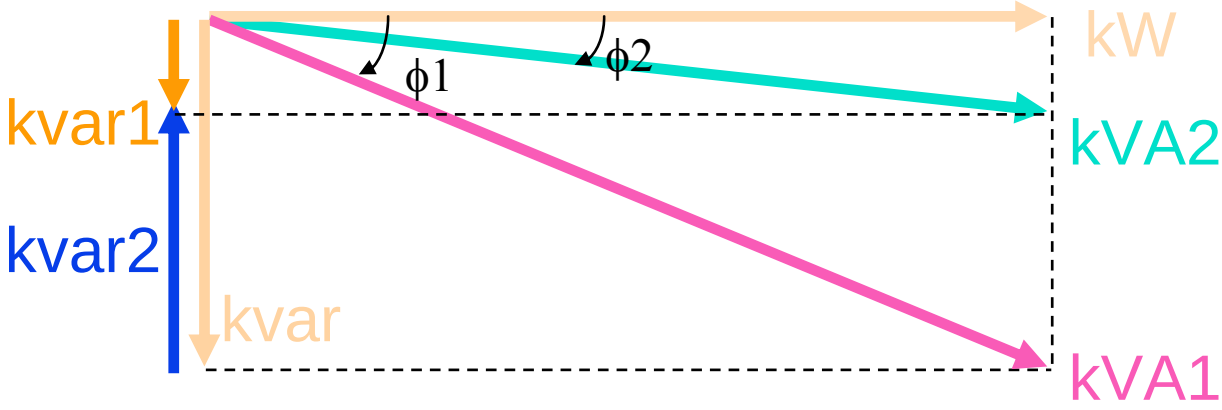
BASIC CONCEPTS

HOW CAN WE IMPROVE THE PF CORRECTION AND THUS REDUCE THE CONSUMED POWER?

BASIC CONCEPTS

The capacitor connected in parallel will draw kvar in the same way than the load but in <u>phase opposition</u> (leading)

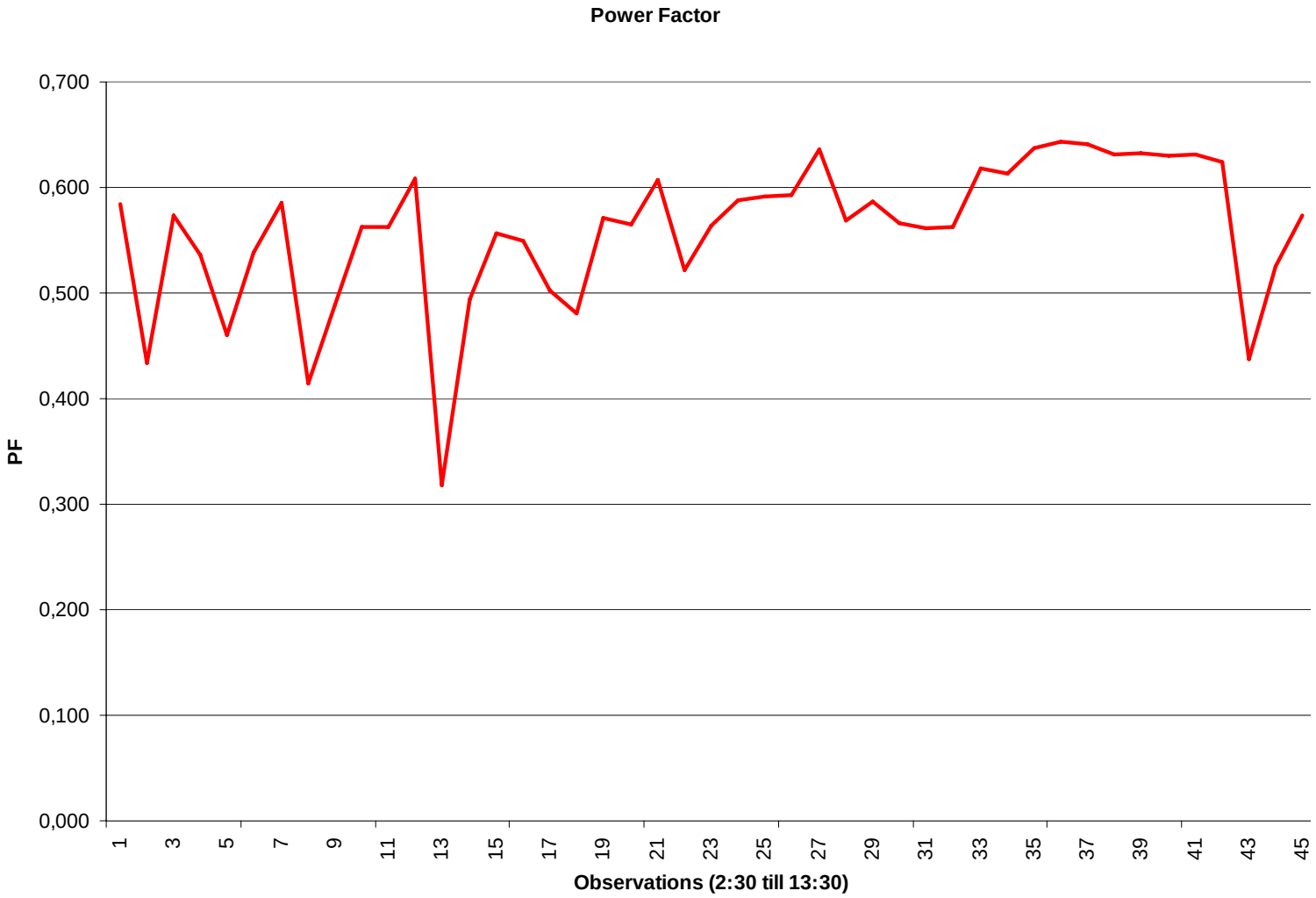




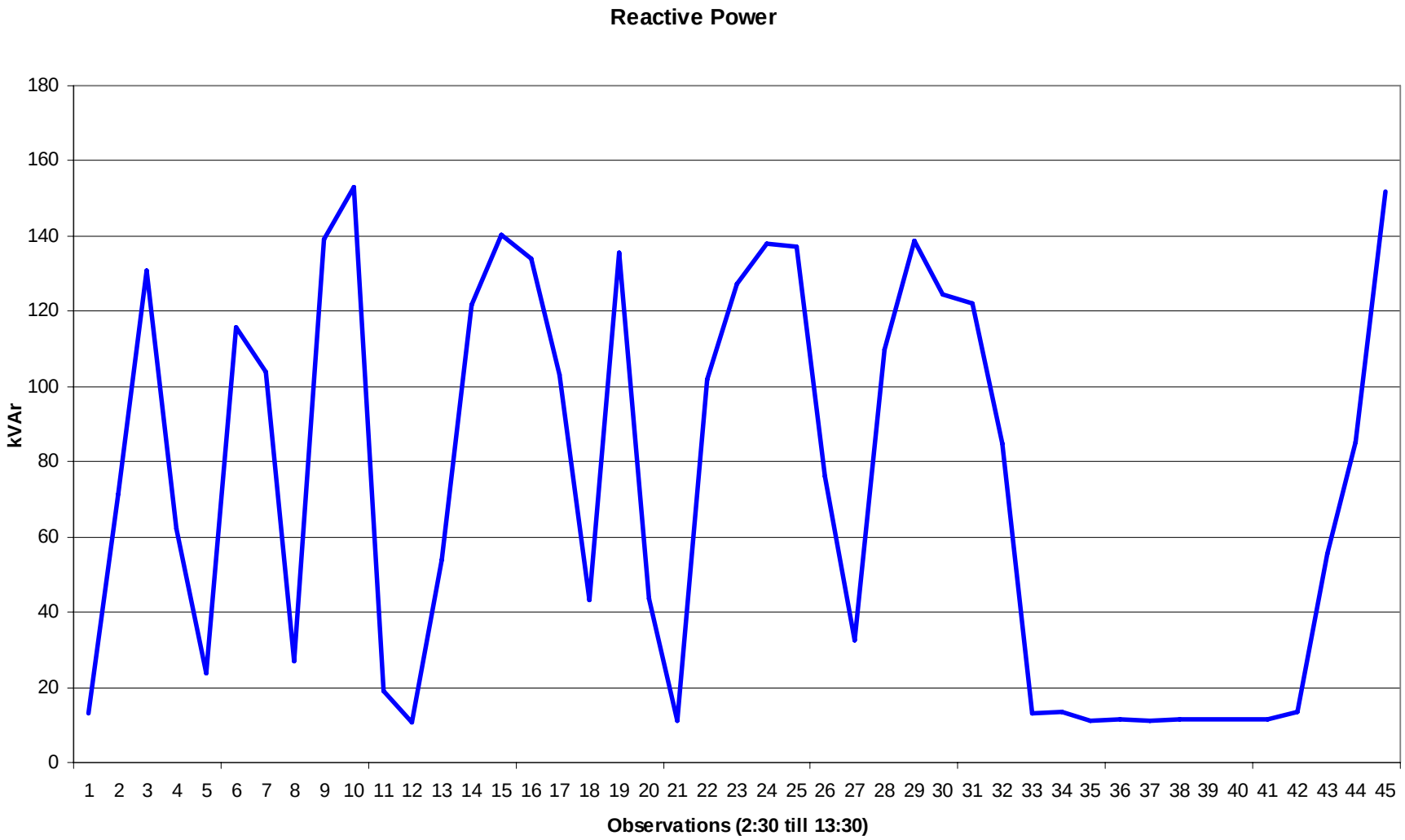
Variable Power Factor

- Slow change
  - Change in Load Pattern (Switching on some of the Loads)
  - Change with time (Morning, Day, Night)
- Fast Change
  - Nature of Load (Rolling Mill, Arc Furnace)

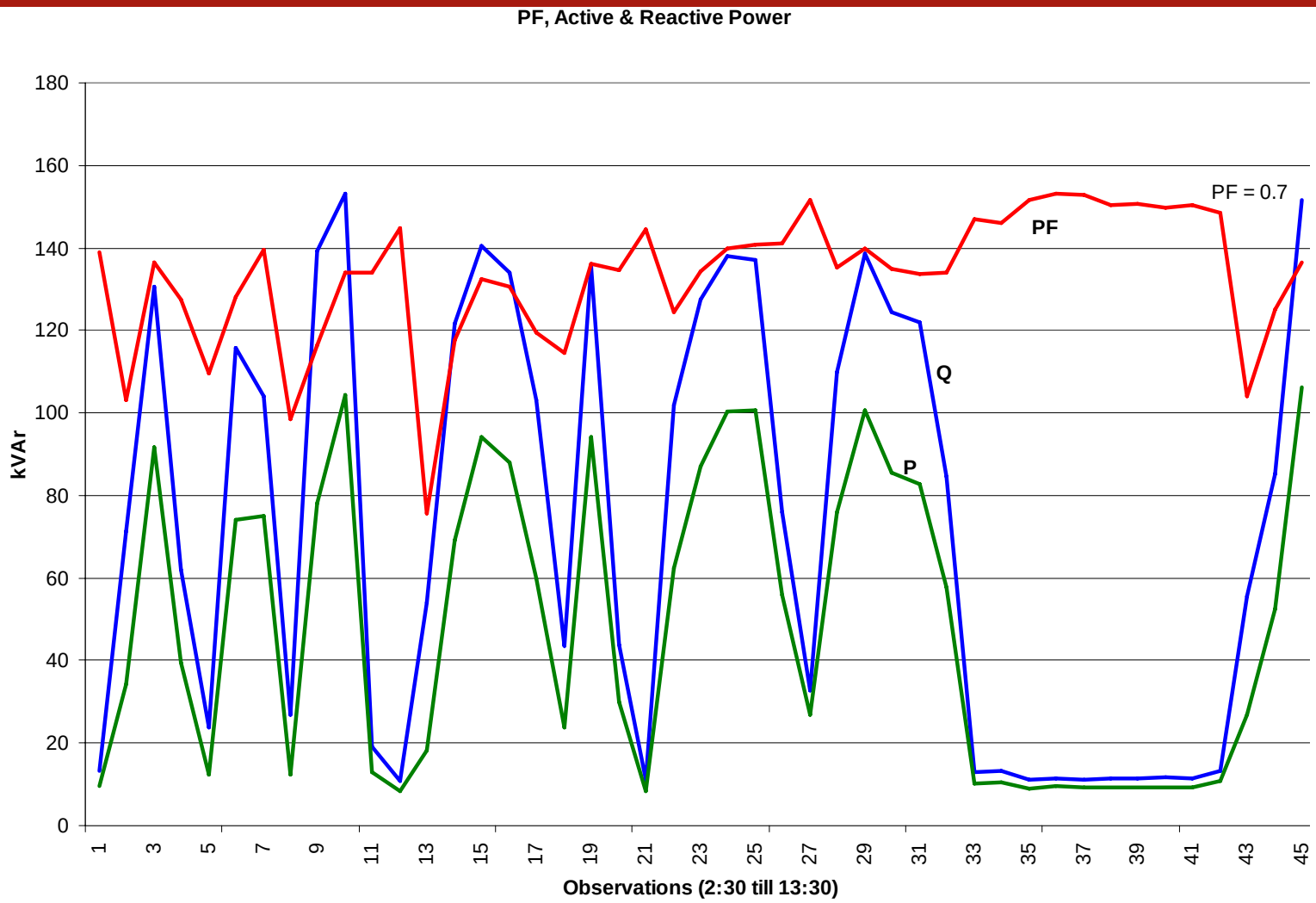
Variable Power Factor



Variable Reactive Power Demand



Variable reactive Power Demand



Disadvantages of Variable PF

- Variable Demand of Reactive Power
- Fixed Capacitor have fixed output (voltage dependent…!!)
- Chances of Over or Under Compensation
- Equipment rated for the maximum demand (derating..!!)

Disadvantages of Variable PF

- Penalty due to Low PF…!!!
- Maximum Demand exceeding the contractual value
- Variable Reactive Power Demand result in Voltage fluctuations.
- Fast Change result in Voltage Flicker

Solution for Variable PF

- Supply of Reactive Energy to Meet Load Demand
- Output of Capacitor Bank should change as per load demand
- A Device to sense the change in Reactive Power Demand (Power Factor Control Relay)
- Control the Switch (Contactor) of Capacitor
- Automatic Capacitor Banks

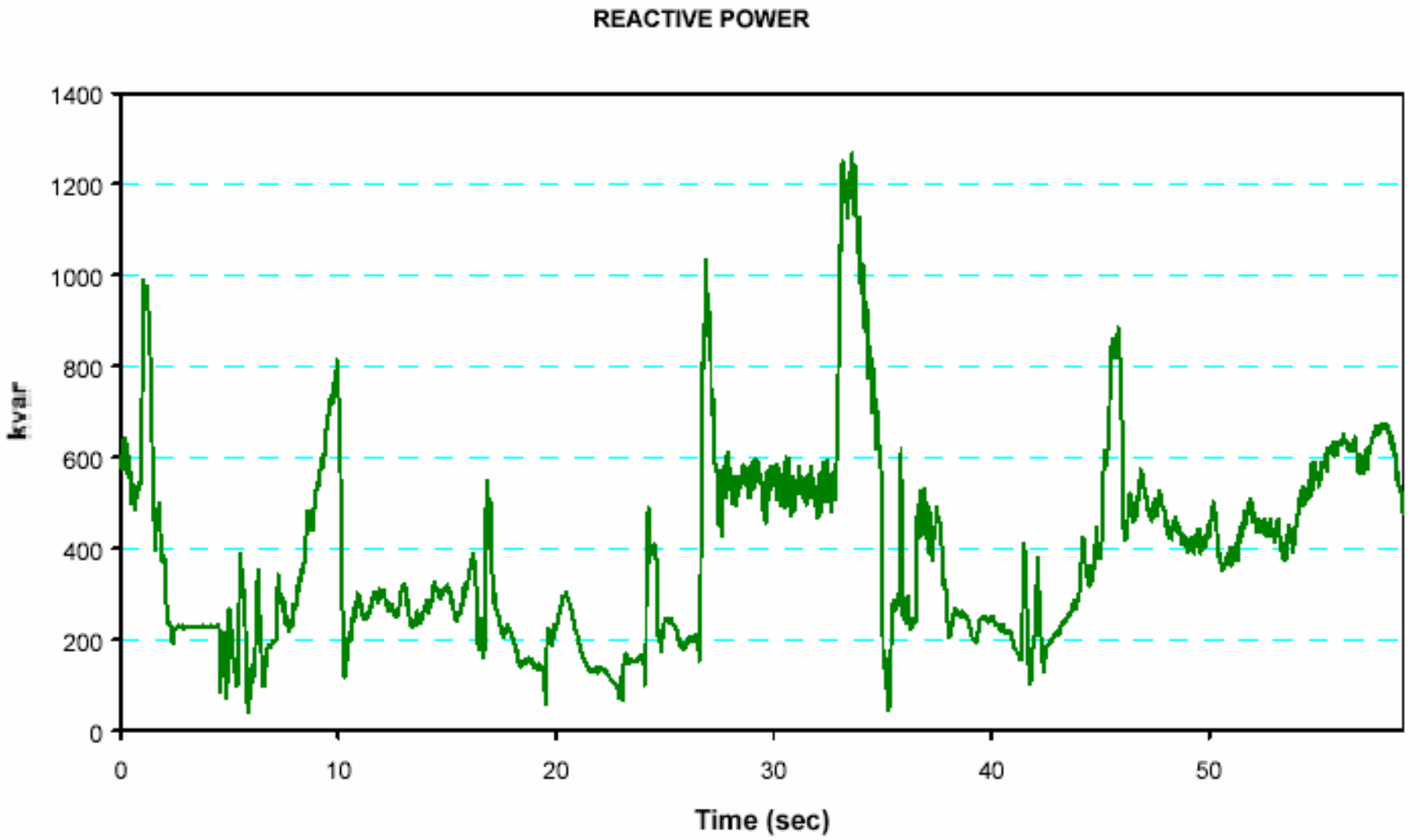
SOLUTION

Contactor switched capacitors

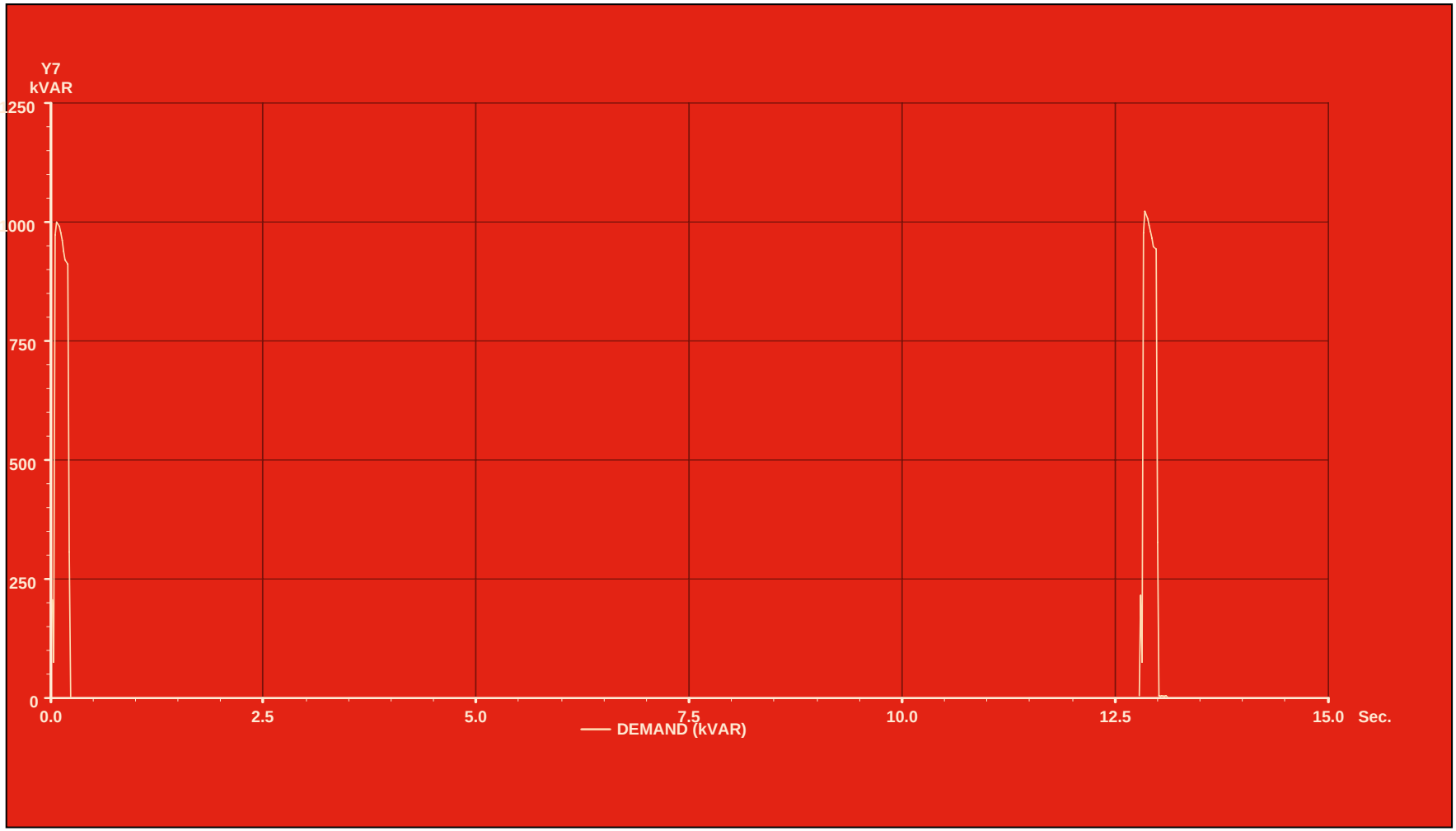
What about very fast varying loads?

- Lifts
- Cranes
- Welders
- Induction furnaces
- Rolling mills

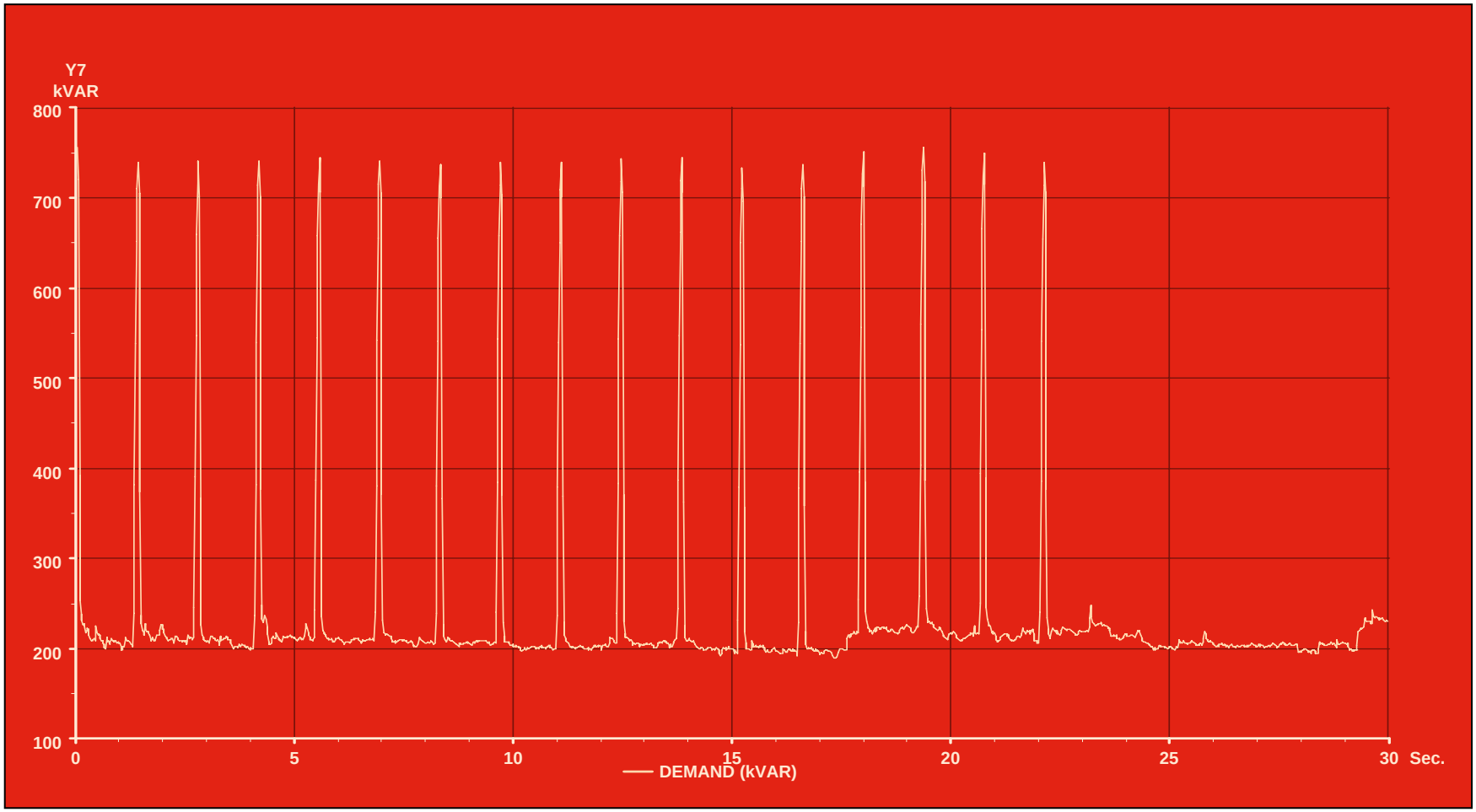
Example of load variations



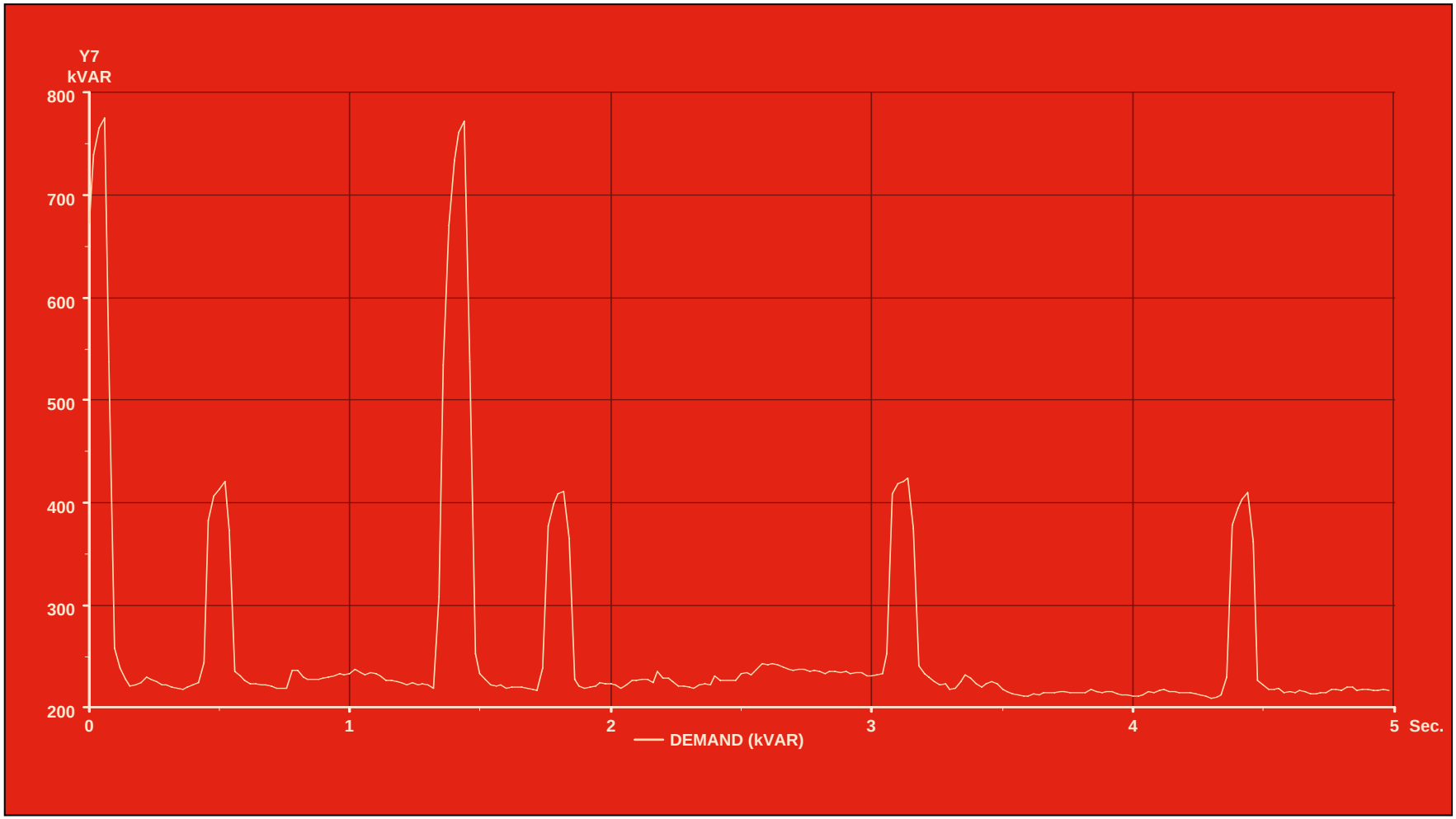
Example of load variations



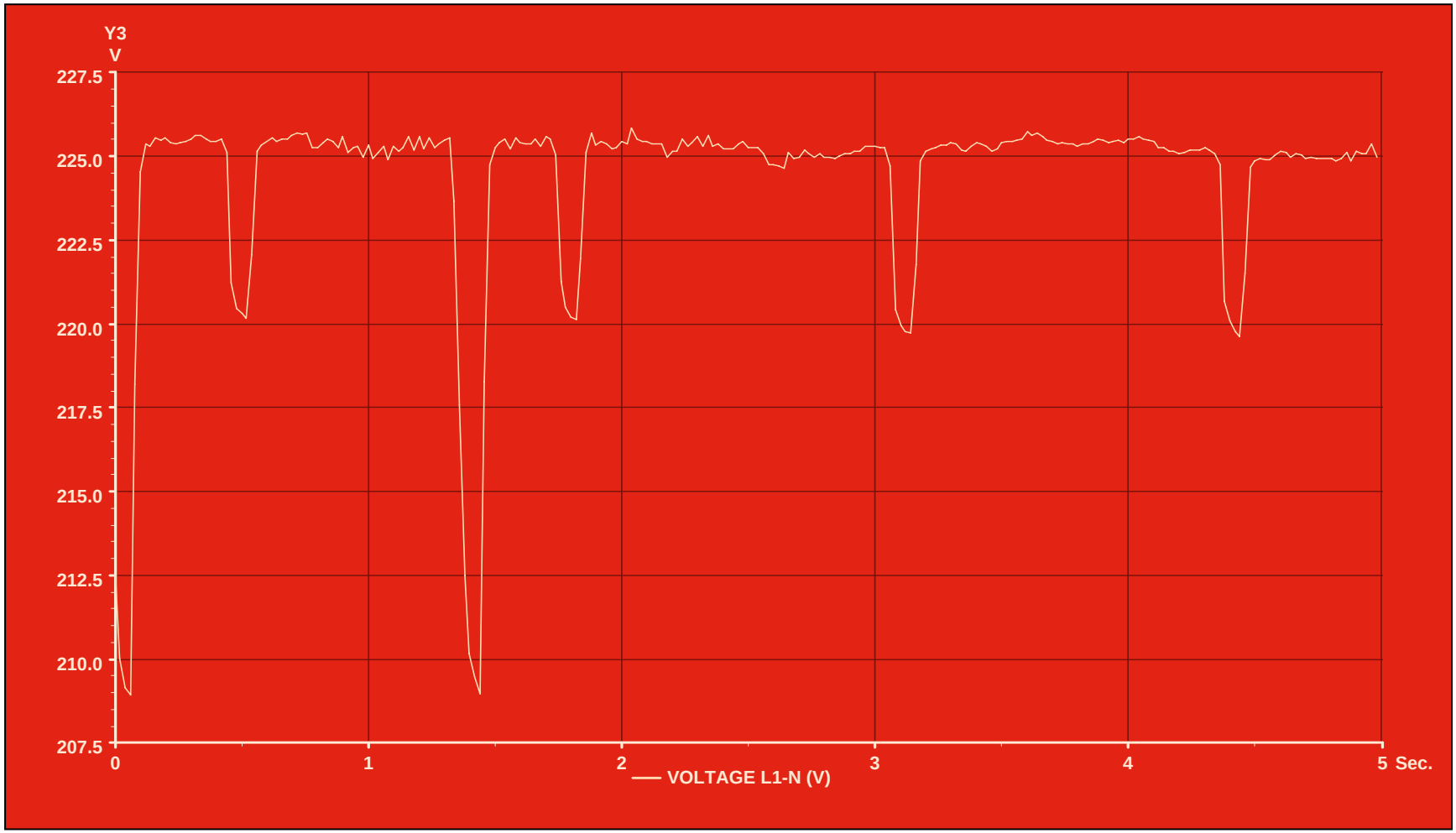
Example of load variations



Example of load variations



Example of voltage drops



Different targets

- Compensate the PF
- Reduce voltage drop
- Decrease flicker effect

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SOLUTION

Thyristor switched capacitors